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(54) **APP DRIVEN BASE STATION
MAN-MACHINE INTERFACE**

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ABSTRACT

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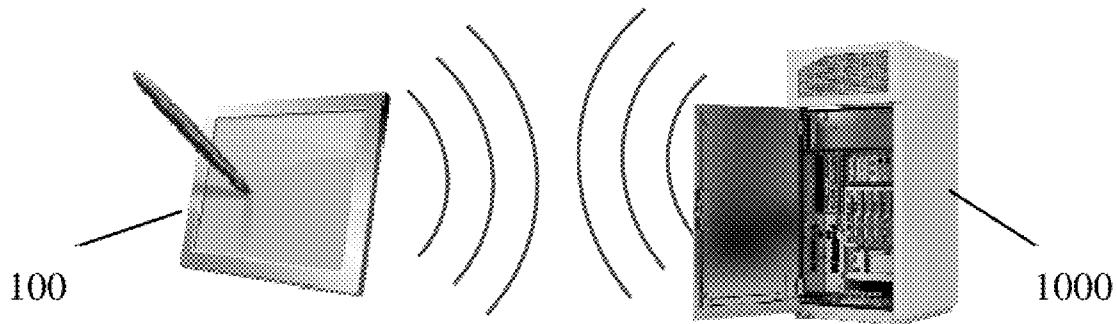
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A user equipment includes a transceiver for communicating with a base station via a wireless communication link, a memory for storing information corresponding to units of the base station, a processor for interpreting an error message received from a unit of the base station by comparing the received message with the stored information and a display for displaying the error in a natural language.



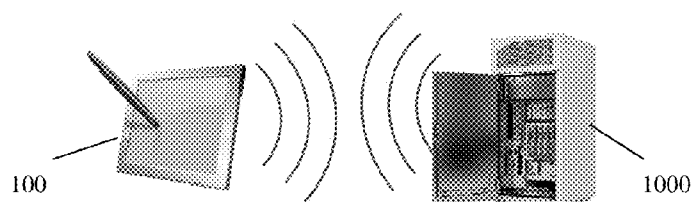


FIG. 1

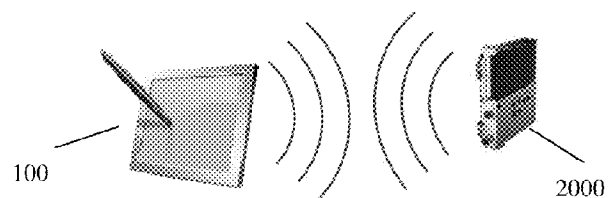


FIG. 2

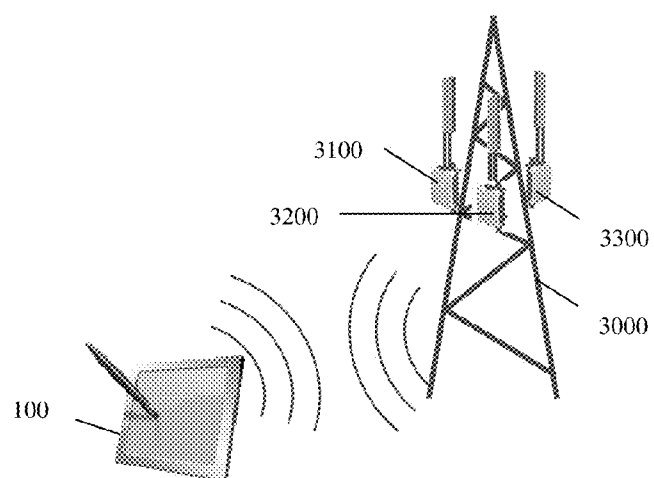


FIG. 3

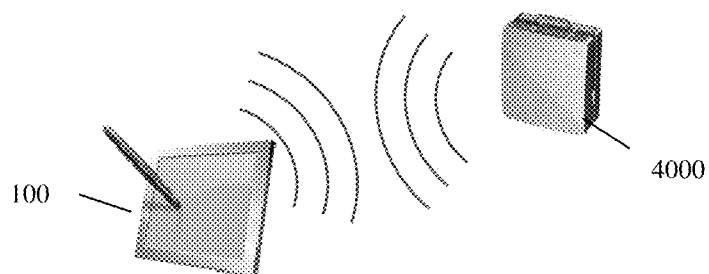


FIG. 4

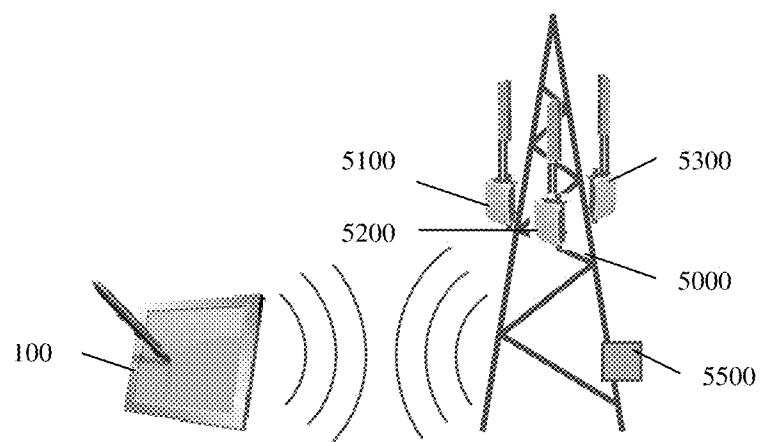
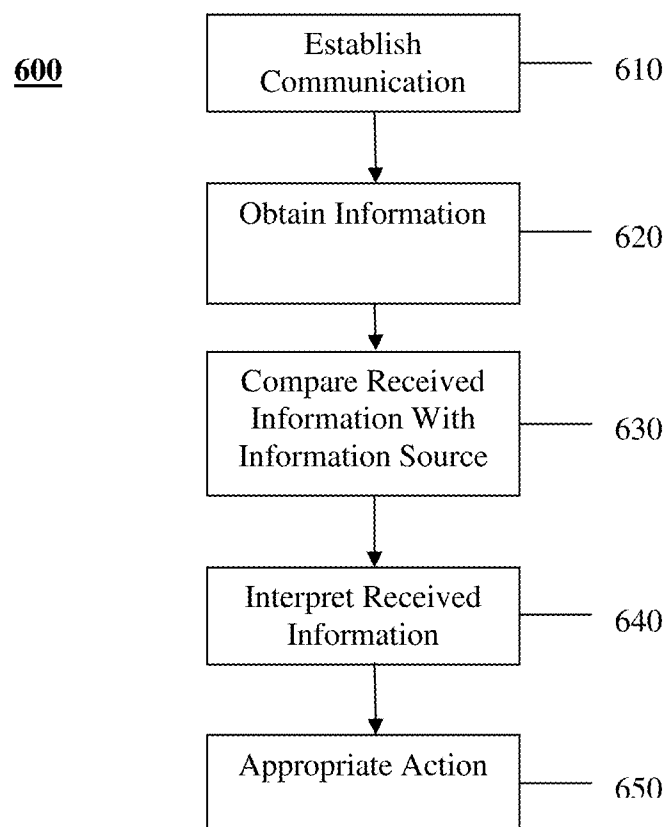
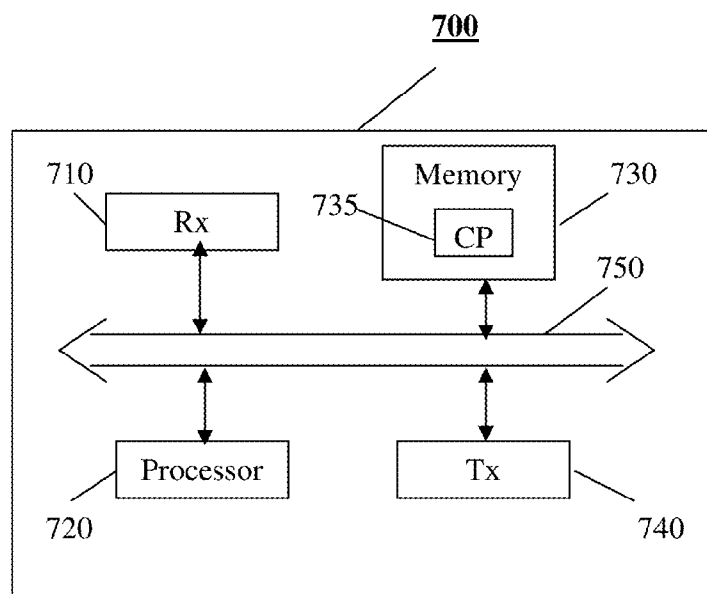
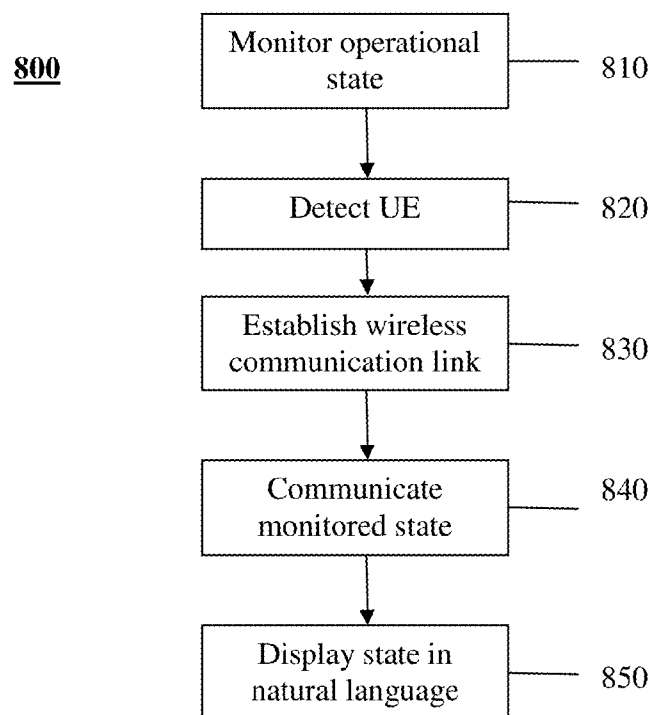


FIG. 5

**FIG. 6**

**FIG. 7****FIG. 8**

APP DRIVEN BASE STATION MAN-MACHINE INTERFACE

TECHNICAL FIELD

[0001] The invention is related to network operations and more particularly to interpreting detected errors in network equipment.

BACKGROUND

[0002] Base stations in mobile telecommunication systems are well known. A network supervising system or operational support system (OSS) of a base station monitors the activity within a telecommunications network. If traffic disruptions are encountered within the network, the OSS can, for example, restart the equipment that facilitates communication within the network.

[0003] In many cases, however, this is inadequate in correcting problems within the network and a site visit to a base station by a service engineer or technician is needed. Initially, the engineer typically checks for physical defects or damages to the base station. If no physical defect or damage is detected, the individual units that form (or are part of) the base station may be evaluated. The functional units can include radio units (RUs), digital units (DUs) and power distribution devices for example.

[0004] Each of these units has a fault indication panel associated with it. The panel may indicate the operational status of the corresponding unit. The status can be represented by a code or the illumination of one or more of a combination of light emitting diodes (LEDs) of various colors (e.g. green, yellow, red and blue). A green LED may indicate proper functioning of all units. A combination of blinking yellow LEDs may indicate different errors in the unit(s).

[0005] Since the interface between a service engineer and the base station where the status is displayed is based on a limited number of LEDs, the service engineer may not know all the codes or combination of LEDs that represent various conditions of the units.

[0006] In such situations, the simplest solution is to replace the unit. The replacement of units can be an expensive proposition as the replaced (i.e. removed) unit is typically sent to a repair center and if no problems are found, it is sent back to the unit owner. Units that are determined not to have any problems (i.e. so called no fault found or NFF) and returned to the owner are usually the most expensive units for the owner.

[0007] In some settings, the units are not easily accessible as they may be protected from, for example, vandalism, etc. The units can also be not easily accessible if mounted on a mast.

[0008] What is desired, therefore, is an improved mechanism for interpreting detected operational states of various units comprising a base station.

SUMMARY

[0009] It should be emphasized that the terms “comprises” and “comprising”, when used in this specification, are taken to specify the presence of stated features, integers, steps or components; but the use of these terms does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

[0010] In accordance with an exemplary embodiment, a user equipment is disclosed. The user equipment comprises: a transceiver for communicating with a base station via a

wireless communication link; a memory for storing information corresponding to units of the base station; a processor for interpreting an error message received from a unit of the base station by comparing the received message with the stored information; and a display for displaying the error.

[0011] In accordance with another exemplary embodiment, a network node is disclosed. The network node comprises: a plurality of units for indicating an operational state of the network; and a transceiver for communicating the indication via a wireless communication link, wherein the indication is an error code.

[0012] In accordance with yet another exemplary embodiment, a method for detecting errors in a communication network is disclosed. The method comprising the steps of: establishing a communication link by a user equipment with a unit of a base station; obtaining information from the unit, the information corresponding to an operational status of the unit; comparing the received information with an information source; interpreting the received information based on the comparison; and recommending an appropriate action based on errors determined by the interpretation.

[0013] In accordance with a further exemplary embodiment, a method of detecting errors in a communication network is disclosed. The method comprises: monitoring an operational state of a plurality of components of the communication system; detecting a user equipment; communicating the represented monitored state to the user equipment via a wireless communication link; and displaying the represented monitored state on the user equipment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The objects and advantages of the invention will be understood by reading the following detailed description in conjunction with the drawings in which:

[0015] FIG. 1 illustrates a communication device communicating with an outdoor base station in accordance with exemplary embodiments;

[0016] FIG. 2 illustrates a communication device communicating with a single PIU (Plug In Unit) of a base station in accordance with exemplary embodiments;

[0017] FIG. 3 illustrates a communication device communicating with a mast mounted base station in accordance with exemplary embodiments;

[0018] FIG. 4 illustrates a communication device communicating with a single unit of a mast mounted base station in accordance with exemplary embodiments;

[0019] FIG. 5 illustrates a communication device communicating with a common communication unit in accordance with exemplary embodiments;

[0020] FIG. 6 illustrates a method in accordance with exemplary embodiments;

[0021] FIG. 7 illustrates a user equipment in accordance with exemplary embodiments; and

[0022] FIG. 8 illustrates a method in accordance with exemplary embodiments.

DETAILED DESCRIPTION

[0023] The various features of the invention will now be described with reference to the figures, in which like parts are identified with the same reference characters.

[0024] The various aspects of the invention will now be described in greater detail in connection with a number of exemplary embodiments. To facilitate an understanding of

the invention, many aspects of the invention are described in terms of sequences of actions to be performed by elements of a computer system or other hardware capable of executing programmed instructions. It will be recognized that in each of the embodiments, the various actions could be performed by specialized circuits (e.g., analog and/or discrete logic gates interconnected to perform a specialized function), by one or more processors programmed with a suitable set of instructions, or by a combination of both. The term "circuitry configured to" perform one or more described actions is used herein to refer to any such embodiment (i.e., one or more specialized circuits and/or one or more programmed processors).

[0025] Moreover, the invention can additionally be considered to be embodied entirely within any form of computer readable carrier, such as solid-state memory, magnetic disk, or optical disk containing an appropriate set of computer instructions that would cause a processor to carry out the techniques described herein. Thus, the various aspects of the invention may be embodied in many different forms, and all such forms are contemplated to be within the scope of the invention. For each of the various aspects of the invention, any such form of embodiments as described above may be referred to herein as "logic configured to" perform a described action, or alternatively as "logic that" performs a described action.

[0026] In exemplary embodiments, methods, apparatus and systems are disclosed for interpreting detected operational status of units within a base station. Exemplary embodiments may provide "on the fly" interpretation of various error codes associated with the operational status of a plurality of units that are part of a base station.

[0027] A communication device having wireless communication capability for communicating with the various units of a base station to obtain the operational status codes (of the units) is disclosed. In exemplary embodiments, an application for interpreting the status codes may be made available to, or stored in, the device. The computing or processing capabilities of the device may be utilized to obtain a greater understanding of the codes than what can be conveyed by the status panels of units of a base station.

[0028] The units of a base station may be implemented in various arrangements such as those illustrated in FIGS. 1-5 for communicating with a communication device. In FIG. 1, base station 1000 may be an outdoor base station.

[0029] A wireless communication link may be established between base station 1000 and a communication device 100. More specifically, base station 1000 may comprise a plurality of units such as the plug in unit (PIU) 2000 as illustrated in FIG. 2. A wireless communication link may be established between the communication device 100 and PIU 2000.

[0030] While base station 1000 of FIG. 1 is illustrated with an open door, the door can also be closed while permitting (or maintaining) wireless communication between base station 1000 and communication device 100. Furthermore, base station 1000 may be located at ground level or can be located on the rooftop of a building.

[0031] A base station may also be implemented as a mast mounted unit such as on mast 3000 as illustrated in FIG. 3. More specifically, a plurality of units, such as units 3100, 3200 and 3300 that are part of the base station, may be mounted on the mast. As illustrated in FIG. 4, a wireless communication link may be established between communication device 100 and mast mounted unit 4000 (representing

any of units 3100, 3200 and 3300). The communication link may be established while the communication device 100 is at ground level (and not on the mast).

[0032] The units within a base station are typically shielded and therefore direct physical access to the equipment is not desirable. Each unit may, therefore, have a transceiver and an antenna for communicating the operational status as a radio signal to communication device 100. The units may also submit their identity. The antenna may not be shielded. The units could respond to commands to determine proper functioning of the units. In some instances, problems with the units may result from a loose cable which can be corrected easily. The unit may then be tested by transmitting a signal (a testing program for example) by the communication device to the unit. The unit may respond by indicating its proper functioning via an appropriate code.

[0033] In some embodiments, a transceiver/antenna may not be desirable for each unit of a base station. In such implementation, each of the units may include ports such as a universal serial bus (USB), a RJ-45 or a similar port. The port may facilitate a (wired) connection of the units at a base station via a hub to a transceiver and an antenna. Each unit within the base station may submit its operational status to the transceiver via the hub. In addition to the operational status, the identity of the (individual) submitting unit may also be sent to the "central" transceiver/antenna (i.e. central for that base station) for transmitting a radio signal to communication device 100.

[0034] As illustrated in FIG. 5, units 5100, 5200 and 5300 (corresponding to units 3100, 3200 and 3300 of FIG. 3) may submit their respective operational status to transceiver 5500. The connection between each of the units (5100, 5200 and 5300) and transceiver 5500 may be a wired connection for example. A wireless communication link may be established between transceiver 5500 and communication device 100.

[0035] Transceiver 5500 may include a log of operational status information received from each of units 5100, 5200 and 5300. This information may be accessed by communication device 100. In some embodiments, the units may be programmed to either provide the operational status periodically or when a problem is detected and/or encountered. If no problem exists and the units are programmed to provide this information periodically, the units can also communicate a positive code to communication device 100 or to transceiver 5500 indicating that no problems exist. The communication device can instruct transceiver 5500 to obtain information from units 5100, 5200 and 5300 in some embodiments.

[0036] In the embodiment described with reference to FIG. 5, communication device 100 can instruct transceiver 5500, based on analyzing information received from the transceiver, to establish a link between communication device 100 and any faulty unit within the units 5100, 5200 and 5300. This may result in communication utilizing both the wireless link between communication device 100 and transceiver 5500 and (wired) connection between transceiver 5500 and units 5100, 5200 and 5300.

[0037] One unit of a base station (such as 3100, 3200, 3300 of FIG. 3) can communicate with communication device 100 at a time. Communication device 100 may be a mobile device such as a smartphone or a portable computing device such as a tablet, a notebook or a similar device with wireless communication capability.

[0038] The wireless interface (between communication device 100 and the units) may be Wi-Fi, Bluetooth, near field

communication (NFC) or a similar type of communication protocol. The communication device **100** can also communicate with the units via “normal” connection such as GSM, WCDMA, LTE, etc.

[0039] The codes received from the individual units (**3100**, **3200**, **3300**) or from the transceiver (**5500**) may be interpreted by accessing code information that is available to communication device **100**.

[0040] A method in accordance with exemplary embodiments may be described with reference to FIG. 6. A communication device or user equipment (UE) **100** may establish a wireless communication link with a unit at **610**. The unit may be a single one of a plurality of units at a base station (such as units **3100**, **3200**, **3300** of FIG. 3) or it may be a transceiver (**5500** of FIG. 5). Communication device **100** may retrieve or obtain operational status information from the unit at **620**. The information can be retrieved based on a request from communication device **100** or upon establishing the communication link. An identity of the unit providing the code may also be received.

[0041] The retrieved information (e.g. a code) may be searched for within a reference source at **630**. The source may be pre-stored in device **100** in some embodiments. If the code cannot be matched with information pre-stored in device **100**, device **100** may access a database at a network location for the reference source. This network location may be accessible via the internet for example. The reference source may include, for example, a user manual for the particular unit or for the base station. The reference source can also simply be a table of codes and their associated meaning(s) and/or conditions, etc. The reference source can also be downloaded to the communication device.

[0042] An interpretation for the code may be obtained at **640**. The interpretation may result in obtaining a description of the received code(s) in a form that is readily comprehended by service personnel such as in plain text, an illustration (drawings, images, etc) or a combination thereof. For purposes of simplification, the term “natural language” is used herein to indicate plain text, illustrations or the combination thereof.

[0043] Based on the interpretation, an appropriate action may be taken at **650**. The interpretation may provide links to other network locations or to other portions of a user manual where the appropriate action(s) may be specified. This may include resetting the unit (i.e. powering “down” the unit and then powering “up” the unit) or requesting that it be replaced for example. In some instances where an intermittent contact between units may show up as errors and become critical for operators, the units need not be replaced. This may also include having links in the interpretation enabling the service personnel to easily order the appropriate/correct spare parts.

[0044] An exemplary user equipment **700** (such as communication device **100** for example) is illustrated in FIG. 7. UE **700** may include, inter alia, a receiving means **710**, a processor **720**, a computer readable medium **730** in the form of memory and a transmitting means **740**. The receiving means and the transmitting means may be combined and referred to as a transceiver or a communication interface. The transceiver or the communication interface may include separate receiving and transmitting modules.

[0045] Receiving means **710** may receive information from individual units (**3100**, **3200**, **3300** of FIG. 3) or from transceiver **5500** (of FIG. 5) for example. Processor **720** may compare the received information with information pre-

stored in memory **730** and determine an appropriate action. Transmitting means **740** may transmit a reset command for example. Receiving means **710**, processor **720**, memory **730** and transmitting means **740** may be interconnected via a bus **750**.

[0046] In one embodiment, in order for the processor **720** to be able to perform the steps illustrated in FIG. 6, memory **730** comprises a computer program (CP) **735** with computer program modules which when run by the processor **720** causes the user equipment **700** to perform all or some of the steps illustrated in FIG. 6.

[0047] Mobile device based Apps (i.e. mobile applications) may also be utilized in some embodiments to analyze (i.e. interpret) the received codes and to make recommendations of appropriate actions to be taken. The base station may also be referred to as a network node. The user equipment or communication device and various other devices highlighted in exemplary embodiments may be compliant with the digital living network alliance (DLNA) standards to facilitate interoperability.

[0048] In other embodiments, a method **800** of detecting errors in a communication network is disclosed. The operational state of a plurality of components of the network may be monitored at **810**. A user equipment or communication device may be detected at **820**. A wireless communication link may be established with the communication device at **830**. The monitored state may be communicated to the user equipment via the wireless communication link at **840**. The communicated state information may be displayed on the user equipment in a natural language (i.e. plain text, illustrations or a combination thereof as described above).

[0049] The communication between the communication device and the units of the base station may be secured using known authentication methods. Authentication keys for units that are to be tested may be made available to an authorized communication device prior to use of the communication device in obtaining information from the units. When the communication device gets in close proximity of a unit to be evaluated, the pre-stored key may be recognized and communication may be established between a communication device and the units of the base station.

[0050] In some embodiments, the various LED combinations indicated on status panels of the units of a base station may be displayed on the communication device. That is, the information may be replicated or emulated on the display of the communication device. This may include utilizing a combination of colors such as red, green, yellow and blue or any other colors. The status can also be transmitted as a code for display in a natural language.

[0051] Exemplary embodiments as described above may be equally applicable for other mast mounted devices, such as antennas, antenna line devices (ALDs) and devices comprising radio communication equipment capable of performing more advanced tasks in the radio communication network such as remote radio units (RRUs). An ALD is a generic term for an addressable physical device, such as an antenna driver or amplifier. A particular ALD can be identified by its global unique identifier.

[0052] Exemplary embodiments may also be applicable in capsule sites or tower tubes such as, for example, masts and/or towers where the base station is placed within the mast at the top, at the bottom or at another level within the mast. Exemplary embodiments may also be utilized to detect errors in base stations implementing antenna integrated radio (AIR).

Embodiments as described herein may be implemented within GSM, 3G or LTE/4G standards utilizing network nodes, NodeBs, eNodeBs, etc.

[0053] Several advantages may be realized by exemplary embodiments. The number of returned units can be reduced. The (error or status) messages can be clearly described in the communication device so more advanced fault handling (i.e. more than simply replacing units for example) can be accomplished on site. Written manuals can be avoided. The need for training on constantly changing and expanding code is obviated. The service engineer need not use an electrical connector. The UE or communication device can be updated with new manuals or latest changes over a network. The devices can provide a direct link to a central service locations for on-line help. As described above, links may also be provided to enable ordering parts via a “click to buy” or similar button on a user interface and therefore, obviate the need for having to write down part numbers or having to order from the office, etc. Such functionality as described in exemplary embodiments may also be used as a distinguishing selling point to operators.

[0054] If an upgrade occurs on the site, a new download can be sent to the service engineer or to his or her communication device so the latest information is obtained. Safety of the service engineers can also be increased as climbing can be avoided to access mast mounted base stations.

[0055] Due to the prevalent use of communication devices, the ease of use provided by exemplary embodiments ensures that the communication device will be used more readily as the increased efficiency reduces the need for service personnel to replace units due information that is limited or in a format that is not easily comprehended.

[0056] The invention has been described with reference to particular embodiments. However, it will be readily apparent to those skilled in the art that it is possible to embody the invention in specific forms other than those of the embodiment described above. The described embodiments are merely illustrative and should not be considered restrictive in any way. The scope of the invention is given by the appended claims, rather than the preceding description, and all variations and equivalents which fall within the range of the claims are intended to be embraced therein.

What is claimed is:

1. A user equipment comprising:
 - a transceiver for communicating with a base station via a wireless communication link;
 - a memory for storing information corresponding to units of the base station;
 - a processor for interpreting an error message received from a unit of the base station by comparing the received message with the stored information; and
 - a display for displaying the error in a natural language.
2. The user equipment of claim 1, wherein the transceiver communicates with a unit of the base station.
3. The user equipment of claim 2, wherein the communication with the unit of the base station is an authenticated communication.
4. The user equipment of claim 1, wherein the transceiver communicates with a common communication device connected to a plurality of units of the base station.
5. The user equipment of claim 1, wherein the transceiver further communicates with a remote location to download an application for providing a user interface on the user equipment.

6. The user equipment of claim 5, wherein the user interface is for displaying the interpreted error message.

7. The user equipment of claim 1, wherein the wireless communication link is one of Bluetooth, WiFi and near field communication (NFC).

8. A network node comprising:

- a plurality of units for indicating an operational state of the network; and
- a transceiver for communicating the indication via a wireless communication link, wherein the indication is an error code.

9. The network node of claim 8, wherein each of the units are associated with a transceiver.

10. The network node of claim 8, further comprising:

- a common communication device connected to each of the units and to the transceiver wherein the common communication device receives the operational state indication from each of the units.

11. The network node of claim 10, wherein the units further comprise a USB port for connecting to the common communication device.

12. The network node of claim 10, wherein the units further comprise a RJ-45 port for connecting to the common communication device.

13. The network node of claim 10, wherein the indication received from the common communication device units includes an identity of the unit associated with the received information.

14. The network node of claim 10, wherein the indication received from the units includes an identity of the unit.

15. The network node of claim 8, wherein the wireless communication link is one of Bluetooth, WiFi and near field communication (NFC).

16. The network node of claim 8, wherein the units are shielded from radio signal interference.

17. The network node of claim 8, wherein the transceiver communicates via the communication link to a user equipment.

18. A method for detecting errors in a communication network, the method comprising the steps of:

- establishing a communication link by a user equipment with a unit of a base station;
- obtaining information from the unit, the information corresponding to an operational status of the unit;
- comparing the received information with an information source;
- interpreting the received information based on the comparison; and
- recommending an appropriate action based on errors determined by the interpretation.

19. The method of claim 18, wherein the information source is stored within the user equipment.

20. The method of claim 18, wherein the information source is at a network accessible location.

21. The method of claim 18, wherein the interpretation comprises displaying an error in the operation of the unit in a natural language.

22. The method of claim 18, further comprising:

- obtaining information from the units via a common communication unit connected to a plurality of the units of the base station.

23. The method of claim 22, further comprising:

- instructing the common communication unit to communicate with one unit of the plurality of units.

24. The method of claim **23**, further comprising:
providing instructions to be communicated by the common communication unit to the one unit of the plurality of units to correct errors associated with the one of the plurality of units.

25. The method of claim **22**, further comprising:
submitting a test program to the one unit of the plurality of units.

26. The method of claim **18**, wherein the operational status information is an indication of a defect in a part of the unit and the appropriate action comprises recommending obtaining a replacement part.

27. The method of claim **26** further comprising: ordering the replacement part via a link on the user interface.

28. The method of claim **27**, wherein the link is a click to buy link.

29. A method of detecting errors in a communication network, the method comprising the steps of:

monitoring an operational state of a plurality of components of the communication system;

detecting a user equipment;

communicating the monitored state to the user equipment via a wireless communication link; and

displaying the monitored state on the user equipment in a natural language.

30. The method of claim **29**, wherein the monitored state is displayed as at least one of text, an image and graphics.

31. The method of claim **29**, wherein the displayed monitored state emulates at least one light emitting diode (LED) having at least one of a plurality of colors.

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